AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

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Batch # 31

1. SUBJECT CLASSIFICATION

A. PRIMARY
Agriculture — AA00-0000-G704

B. SECONDARY
General--Korea Rep.

2. TITLE AND SUBTITLE
Briefing charts on the Korean agricultural sector simulation project

3. AUTHOR(S)
(101) Korean Agr.Sector Study Team

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1975	34p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
Mich.State

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)
(In KASS issue paper 9)

9. ABSTRACT

10. CONTROL NUMBER	11. PRICE OF DOCUMENT
PN-AAB-773	
12. DESCRIPTORS	**13. PROJECT NUMBER**
Korea Rep. Simulation Visual aids	**14. CONTRACT NUMBER** CSD-2975 Res.
	15. TYPE OF DOCUMENT

AID 590-1 (4-74)

BRIEFING CHARTS

ON THE

KOREAN AGRICULTURAL SECTOR SIMULATION PROJECT

KASS Issue Paper 9

Korean Agricultural Sector Simulation Project

Joint Project of USAID and ROKG
Contract AID/csd-2975

Ministry of Agriculture and Fisheries
National Agricultural Economics Research Institute
Seoul, Korea

Michigan State University
Department of Agricultural Economics
East Lansing, Michigan

May, 1975

INTRODUCTION

Project Objectives

Project Organization

Role of Computer

Problem-Solving Process

General System Simulation Approach

PROJECT OBJECTIVES

Develop comprehensive models of:

KOREAN AGRICULTURAL SECTOR (KASM)

For the purpose of:

1. Evaluating implications of alternative development policies on the

   (a) production and consumption of food
   (b) quality of rural life
   (c) contributions from agricultural sector to national development

2. Assess impact of outside "shocks," e.g.

   (a) sharp increases in world prices
   (b) bad weather

3. Assist in preparation of short-range to medium-range plans (5-15 years)

GRAIN MANAGEMENT PROGRAM (GMP)

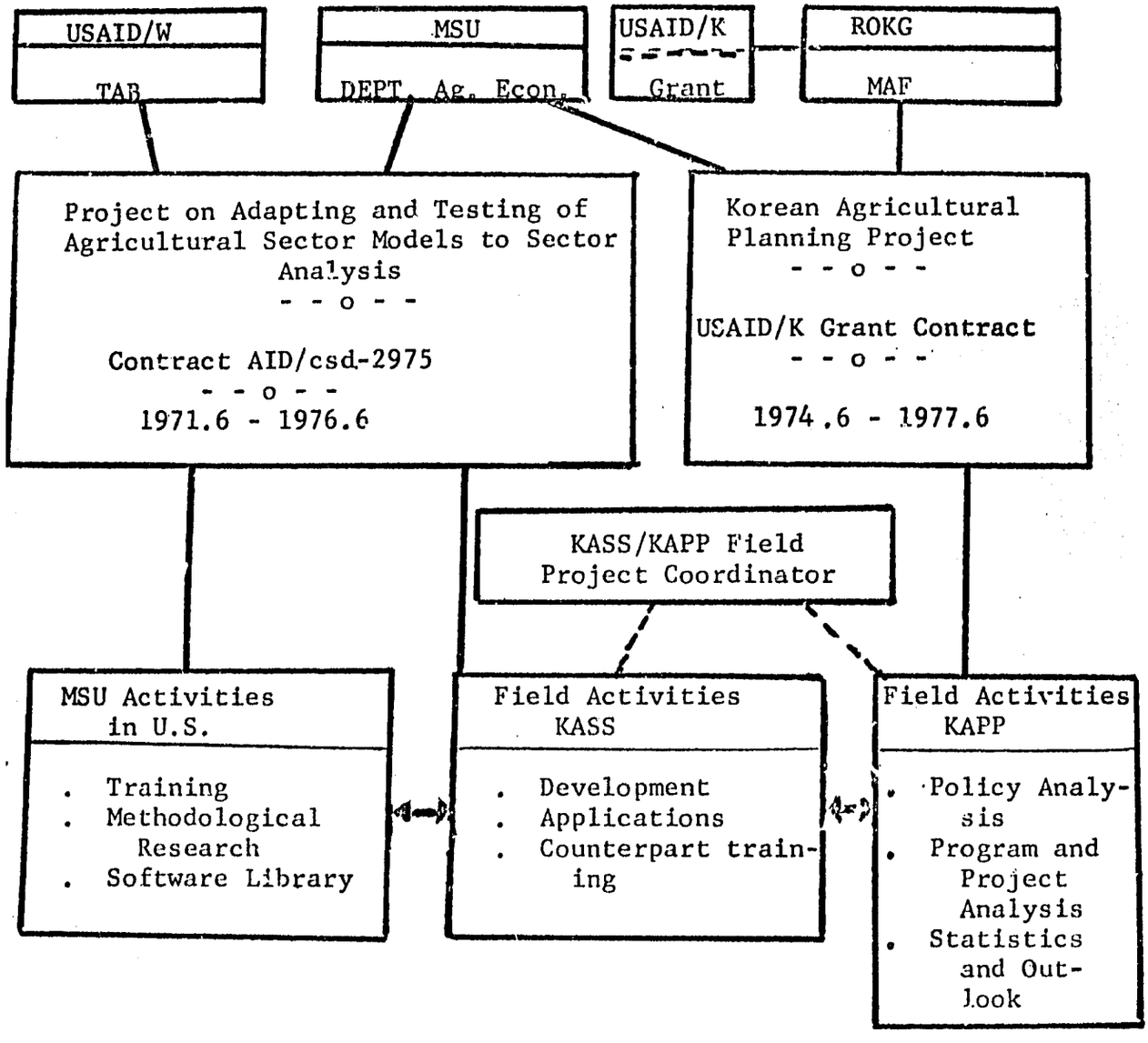
For the purpose of:

1. Evaluating implications of alternative price, purchase-and-sale, and trade policies by the government in the grain market on:

   (a) seasonal price patterns
   (b) special grain management account
   (c) warehouse inventories

2. Test different management control mechanisms

PROJECT ORGANIZATION AND ACTIVITIES



PERSONNEL

MSU/KASS PERSONNEL	MSU/KAPP PERSONNEL
1 Social Scientist	Plicy Analyst
2 Systems Scientist	Program and Project Analyst
1 Agricultural Economist	Statistician
1 Computer Programmer	Outlook Analyst

KASS COUNTERPART INSTITUTION

Ministry of Agriculture and Fisheries (MAF)
National Agricultural Economics Research Institute (NAERI)
Sector Analysis Division

COMPUTER FACILITIES

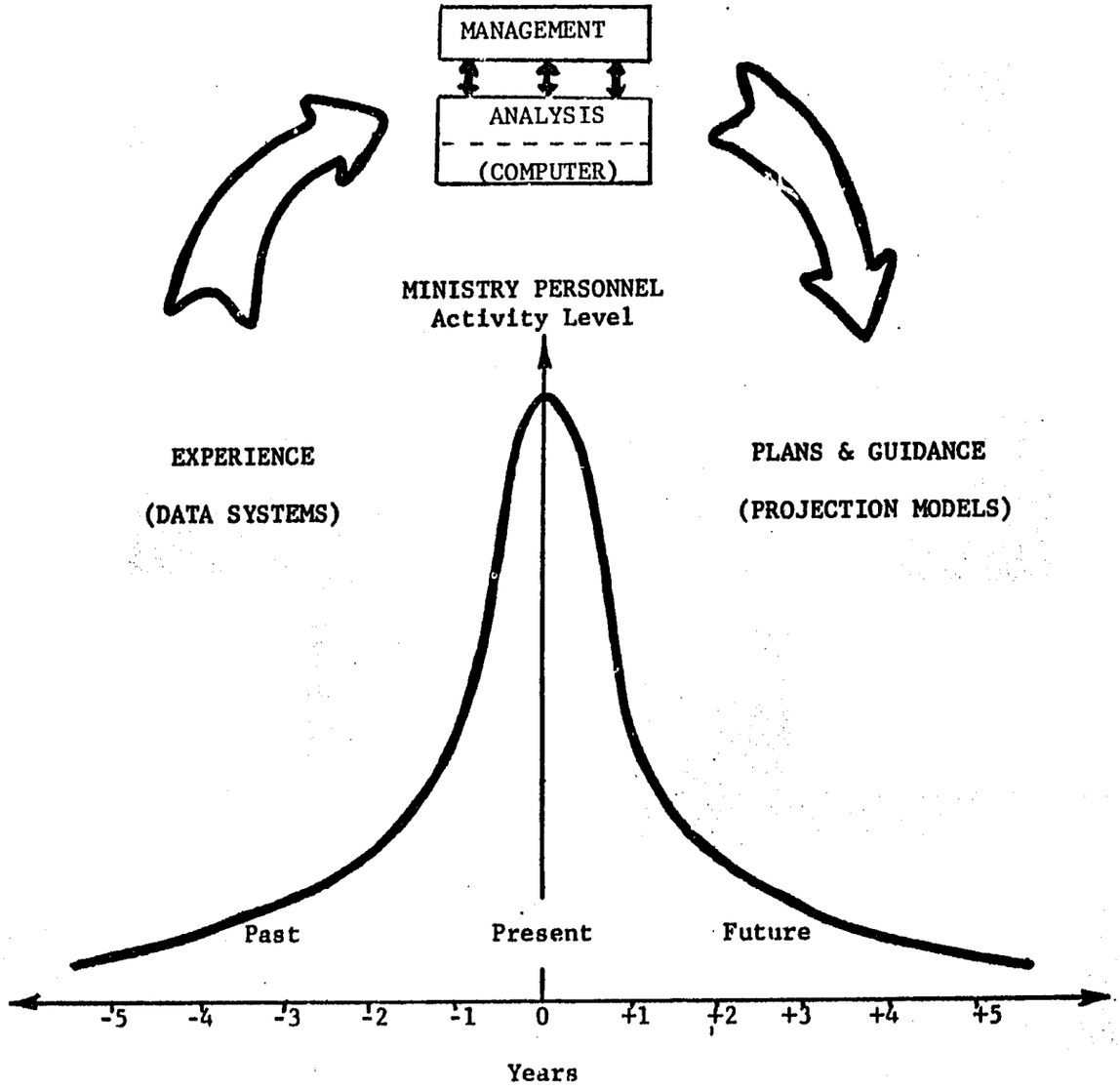
Korea Institute of Science and Technology (KIST)
CDC Cyber 70 Computer

National Computer Center
Univac 1108 Computer

CONSULTATION WITH OTHER INSTITUTIONS

Economic Planning Board (EPB)
Korea Development Institute (KDI)
Office of Rural Development (ORD)
  Institute of Agricultural Sciences (IAS)
  Crop Improvement Research Center (CIRC)
Korea Advanced Institute of Science (KAIS)
Korea Institute of Family Planning (KIFP)

CONTRIBUTION OF COMPUTER-BASED ANALYSIS
TO MANAGEMENT



TIME ORIENTATION OF CURRENT MINISTRY ACTIVITIES

PROBLEM-SOLVING PROCESS

The Problem-solving process involves a continuous, constructive exchange of ideas and information between (1) investigators and (2) decision makers. This interaction is with respect to :

Problem Definition

- Value system and cultural context
- Goals and objectives
- View of world: Relevant data
  Present situation
  Trends
- Definition of system: Relevant sectors and flows
  Policy instruments
  Performance indicators

Analysis needed in order to reach decisions.

- Use of models: Descriptive-intuitive
  Computerized mathematical
- Projecting consequences of alternative courses of action

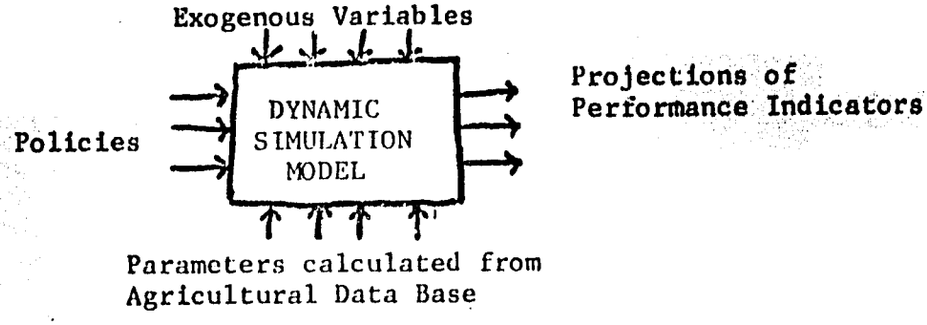
The administration or execution of decisions by action agencies

Observation of results and the bearing of responsibility for decisions and actions

Continual reassessment of problems and policies

GENERAL SYSTEM SIMULATION APPROACH

- GENERAL with respect to:
  - Data Sources: Time series data; Experimental data; Knowledgeable intuition; Cross-sectional data; Etc.
  - Modeling techniques: Input-output analysis; Linear Programming; Differential equations; Simultaneous equations; Off-line inputs; etc.
- SYSTEM
  - Modular : Software components; Work assignments
  - Interacting: Linked components; Feedback effects
- SIMULATION
  - Time paths of inputs and outputs
  - Time delays on feedback effects



COMPUTER POWER

Speed
Accuracy
Process large quantities of data
Analyze many complex interrelationships

UTILIZED FOR

DATA SYSTEMS

- Data storage
- Retrieval
- Updating
- Display past trends

LINKAGE

- Update model initial values
- Update parameter estimates
- Flexible data base aggregation, e.g.
  - Sector I/O
  - Commodity groupings
  - Regions
  - Other

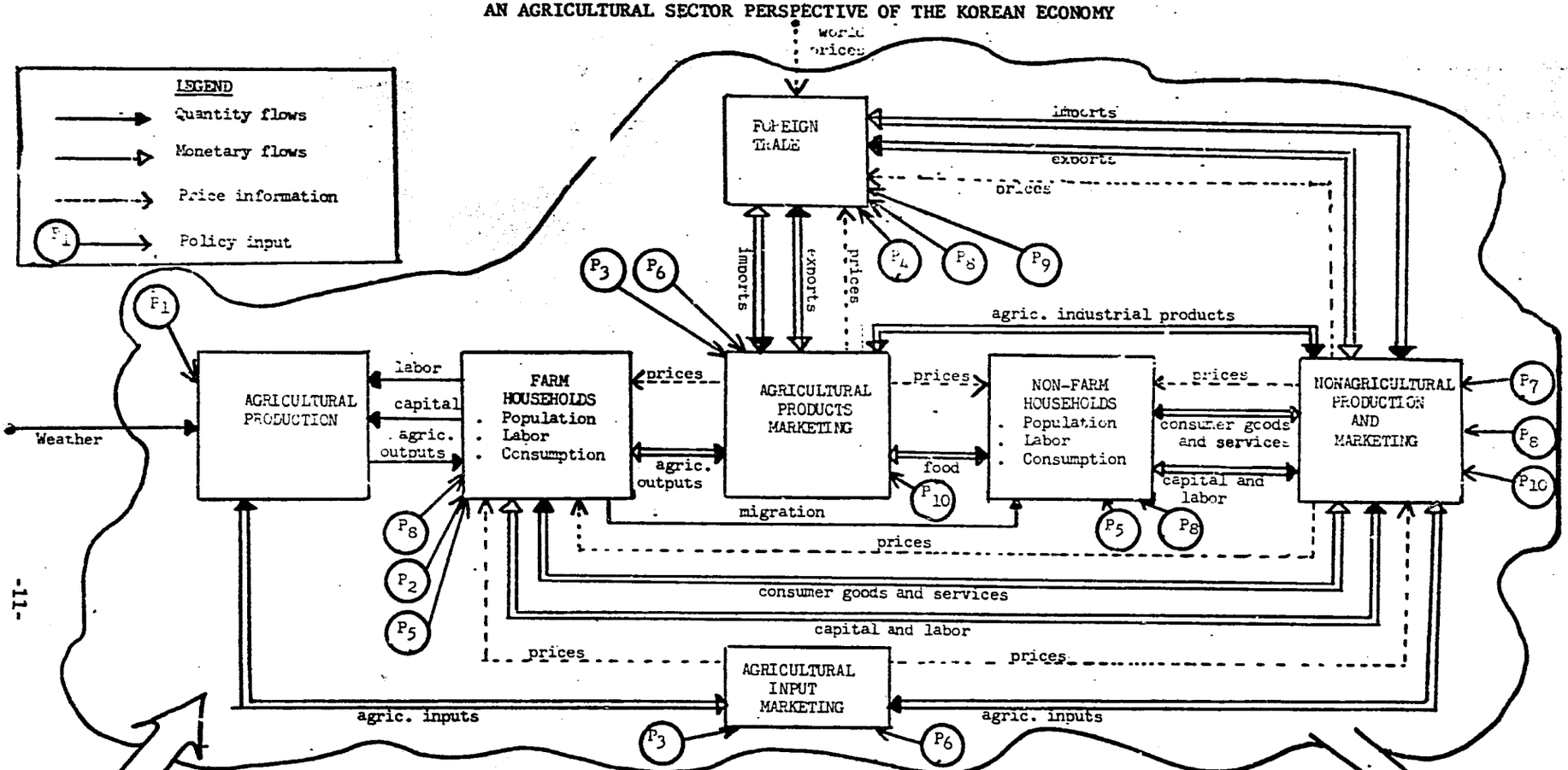
PROJECTION MODELS

- Project current trends
- Test alternative policies
- Asses system shocks
- Rolling plans
- Check data consistency

KOREAN AGRICULTURAL SECTOR MODEL

KASM

AN AGRICULTURAL SECTOR PERSPECTIVE OF THE KOREAN ECONOMY



POLICY INSTRUMENTS

P_1	Agricultural development -- land, water, infrastructure, crop improvement, mechanization
P_2	Agricultural Credit
P_3	Price controls and subsidies
P_4	Import/export controls and subsidies
P_5	Population control, health and welfare
P_6	Market improvement
P_7	Rural industrialization
P_8	Tax rates -- income, indirect, customs, etc.
P_9	Monetary -- interest rates, foreign exchange rates
P_{10}	Public consumption and investment

PERFORMANCE INDICATORS

GDP -- total, per capital; nominal, real; agric., nonagric.; growth rate
Income -- total, per capita; nominal, real; agric., nonagric.; farm, non-farm
Trade balance -- exports, imports; agric., related nonagric.
Nutrition
Employment
Tax revenues
Value added
Capital formation
Population
Special accounts status -- e.g., GMSA
Inflation

VERSIONS OF THE
KOREAN AGRICULTURAL SECTOR MODEL

Date	Version No.	New or Improved Components/Models	Utilization
1973	KASM 1	Annual Crop Production Perennial Crop Production Seasonal Crop Production Farm Consumption Urban Demand Population	KASS Report (1972) Investment Study Report (1972) MAF 1973-81 Projections (1973)
1975	KASM 2	Resource Allocation Livestock & Feed Market Price International Trade	4FYP Medium-range Projections (5-15 years) Price Policy Analysis
1975	KASM 3	National Economy MAF Accounting Migration Yield & Farm Input	Investment Policy Analysis National Economy Policy Analysis
1976	KASM 4 . . n	Livestock Cohort Component Fishery Forestry Linkage with data system for flexible disaggregation by region, commodity, sector. Processing Marketing	Regional Analysis Weather Impact Analysis MAF Fiscal Policies Annual Production Plan Market Policy Analysis

KASM 1

Developed to speed preparation of 1972 KASS Report

Primarily an accounting model, except for:

Analytical Components

- Annual and Perennial Crop Production
- Seasonal Crop Production

    Production
    Labor Utilization

- Farm Consumption
- Urban Demand
- Population

Much off-line analysis required to:

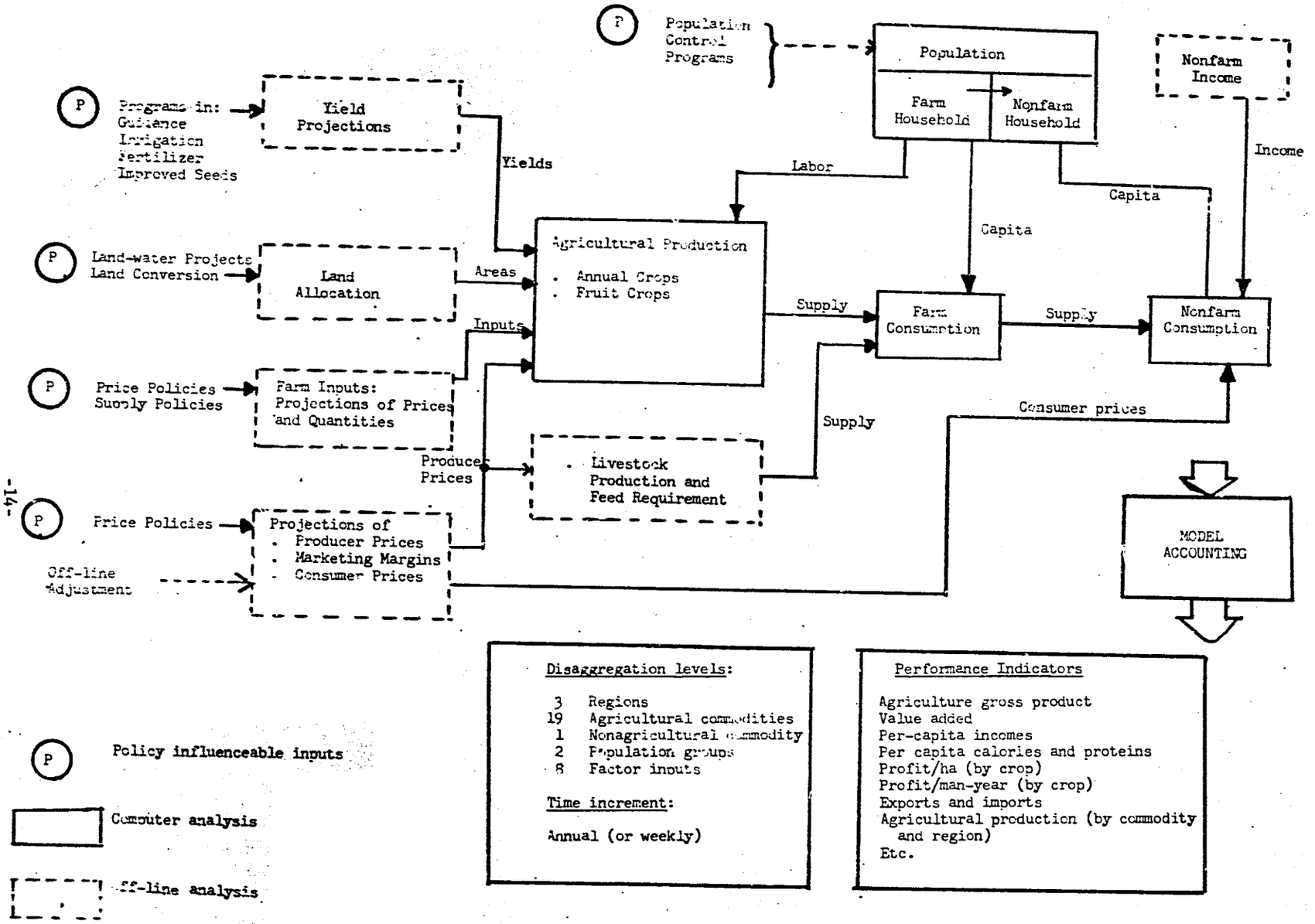
- Determine effects of policies and programs on:

    Yields
    Land Base
    Production Inputs
    Livestock Production
    Feed Grain Consumption

- Balance supply and demand thru adjustments in:

    Producer Prices
    Land Allocation
    Import/Export Levels

KASM 1 SCHEMATIC



KASM 2-3: CHARACTERISTICS

Policy Variables

- Price Supports at Farm Level
- Price Ceilings at Consumer Level
- Commodity Import/Export Regulation
- Regulation of Land Allocation
- Commodity Taxes
- Public Investments in Land and Water Development, Crop Improvement Research and Extension
- Factor Inputs Subsidies
- Credit

Policy Influenceable Variables

- Population Birth & Death Rates
- Nonagricultural Contribution to Farm Household Income
- Livestock Yields
- Import Substitution in Nonagriculture
- Fisheries Production

Planning Horizon

- 5-20 Years

Time Increment

- Annual Cycle

Analytical Components

- National Economy (16 sectors)
- Population and Migration
- Yields and Input Demands
- Farm-Firm Resource Allocation
- Crop Production
- Livestock Production
- Demand-Price
- Agricultural Foreign Trade
- MAF Accounting
- Sector-Level Accounting
- National Accounting

KASM 2-3: CHARACTERISTICS (con't)

Population Groups (2)

Farm Household
Nonfarm Household

Agricultural Subsectors (4)

Annual Crop
Perennial Crop
Livestock
Fishery

Regions (1 or n)

National or "Single Crop" Region or "Double Crop" Region "Upland" Region

Agricultural Commodities (19)

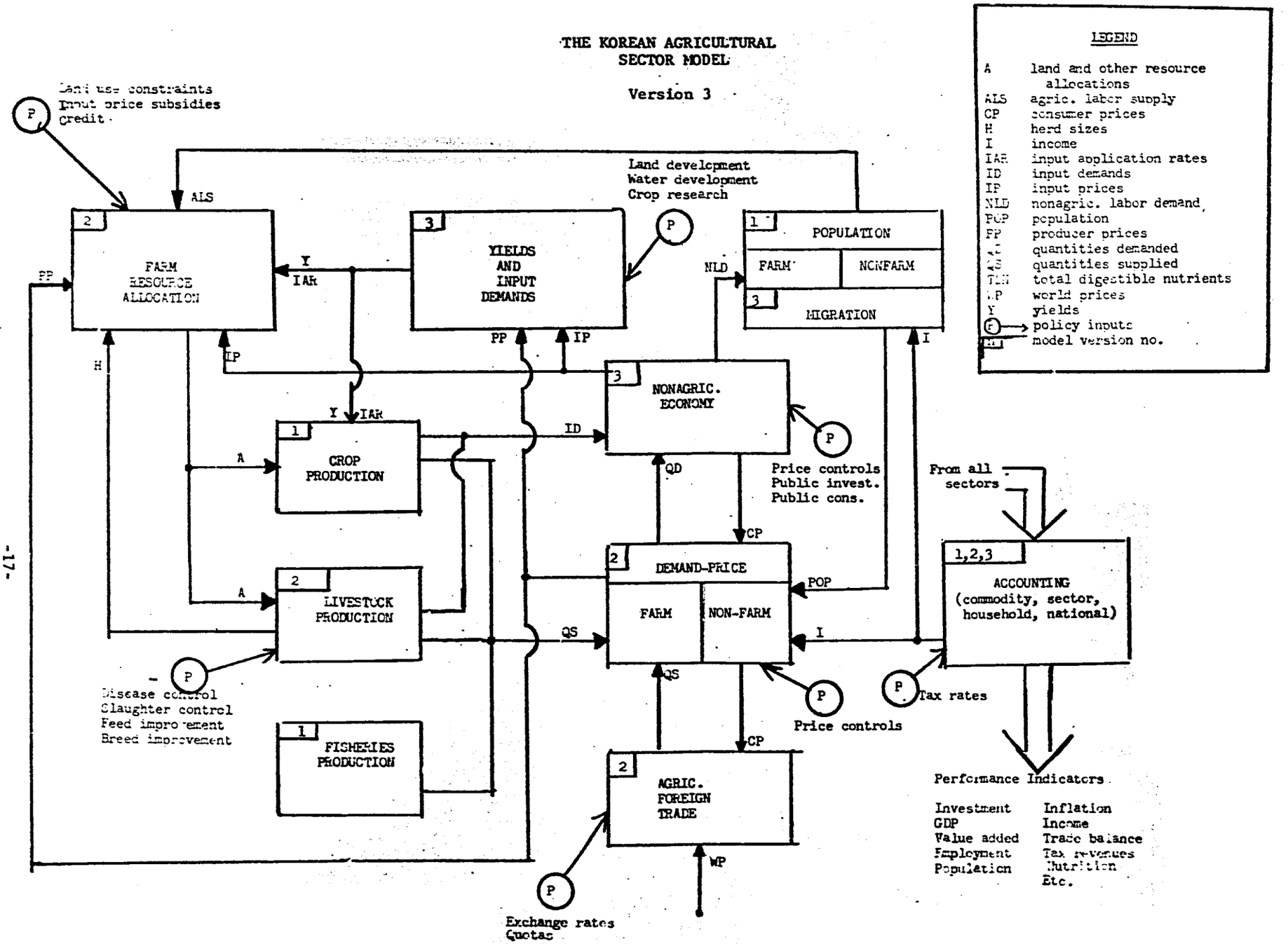
1) Rice	6) Pulses	11) Silk (Mulberry)	16) Chicken
2) Barley	7) Vegetables	12) Industrial Crops	17) Eggs
3) Wheat	8) Potatoes	13) Beef	18) Fish
4) Other grains	9) Tobacco	14) Milk	19) Residual
5) Fruits	10) Forage	15) Pork	

Land Categories (4)

Paddy
Summer Upland
Winter Upland (includes double-cropped paddy)
Pasture

Factor Inputs (12)

Land
Labor
Capital (farm implements, tillers, transplanters)
Chemical Fertilizer
Organic Fertilizer
Pesticide
Seed
Fuel
Oil
Other Inputs


THE KOREAN AGRICULTURAL SECTOR MODEL
Version 3
LEGEND
A land and other resource allocations
ALS agric. labor supply
CP consumer prices
H herd sizes
I income
IAR input application rates
ID input demands
IP input prices
NLD nonagric. labor demand
POP population
PP producer prices
QD quantities demanded
QS quantities supplied
TDN total digestible nutrients
WP world prices
Y yields
P policy inputs
model version no.
Land use constraints
Input price subsidies
Credit
Land development
Water development
Crop research
ALS
PP
Y
IAR
H
IP
NLD
I
FARM RESOURCE ALLOCATION
YIELDS AND INPUT DEMANDS
POPULATION
FARM
NONFARM
MIGRATION
NONAGRIC. ECONOMY
CROP PRODUCTION
LIVESTOCK PRODUCTION
FISHERIES PRODUCTION
ID
A
QD
CP
Price controls
Public invest.
Public cons.
DEMAND-PRICE
FARM
NON-FARM
POP
QS
From all sectors
ACCOUNTING (commodity, sector, household, national)
Disease control
Slaughter control
Feed improvement
Breed improvement
Price controls
Tax rates
AGRIC. FOREIGN TRADE
WP
Exchange rates
Quotas
Performance Indicators
Investment
GDP
Value added
Employment
Population
Inflation
Income
Trade balance
Tax revenues
Nutrition
Etc.

KASM 2: RESOURCE ALLOCATION COMPONENT

Recursive Linear Programming model of aggregate farm-level resource allocation

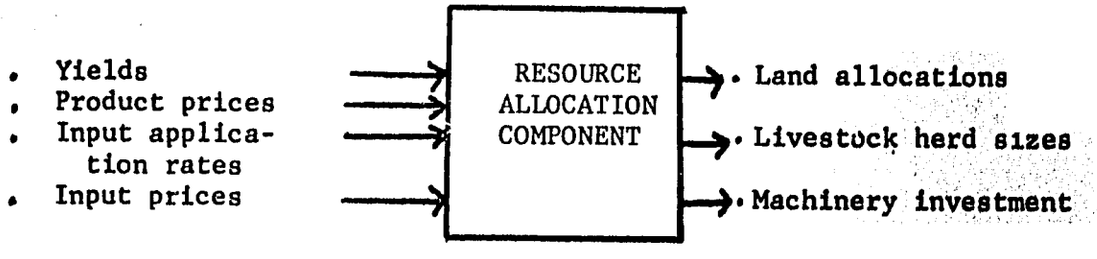
1) Activities (39)

- Crop activities (22)
- Livestock activities (6)
- Livestock feed activities (9)
- Machinery investment activities (2)

2) Constraints (39)

- Land constraints (6)
- Power constraints (human, animal, machinery) (7)
- Animal feed balance constraints (5)
- Crop commodity production constraints (13)
- Livestock commodity production constraints (7)
- Machinery investment constraint (1)

Sector Model Linkage



KASM 2: DEMAND-PRICE COMPONENT

Farm Household Consumption Subcomponent

- Single-equation, step-wise, linear estimation of farm consumption for each commodity
- Inputs: Lagged producer prices
  Lagged farm household income
- Parameters: Farm price elasticities
  Farm income elasticities

Nonfarm Household Demand Subcomponent

- Nonfarm household demand based on nonfarm population and nonfarm expenditure level
- Total aggregate demand is constrained to be equal to projected total expenditure levels
- Elasticities constrained to meet homogeneity principle by adjusting food/nonfood cross elasticities
- Parameters: Nonfarm price and cross price elasticities
  Nonfarm income elasticities

Consumer Price Determination Mechanism

- Simultaneous determination of consumer prices or import/export quantities
- Prices determined by "market mechanism" if imports/exports specified
- Import/export determined by "market mechanism" if bounds on prices are policy-specified
- Assumptions:
  - Market clearing
  - No carry-overs

KASM 1,3: POPULATION AND MIGRATION COMPONENT

Age-Sex Cohort Model

- 2 Population Streams
  - Farm household population
  - Nonfarm household population

Mechanisms

- Apply age specific birth rates and sex ratio to determine male and female births for each stream
- Apply age-sex specific mortality rates to determine cohort survival to next age group
- Apply age-sex specific migration rates to determine off-farm migration
- Migration rates are functions of nonfarm job opportunities and farm/nonfarm living standard differentials

Data Requirements

- Initial farm-nonfarm, age, sex distribution
- Age specific birth rates
- Age-sex specific death rates
- Age-sex specific migration rates
- Age-sex specific nutritional requirements
- Economically active population (peak and base)

Outputs for Sector Model

- Farm population
- Nonfarm population
- Agricultural labor available (peak season)

KASM 3: NATIONAL ECONOMY COMPONENT

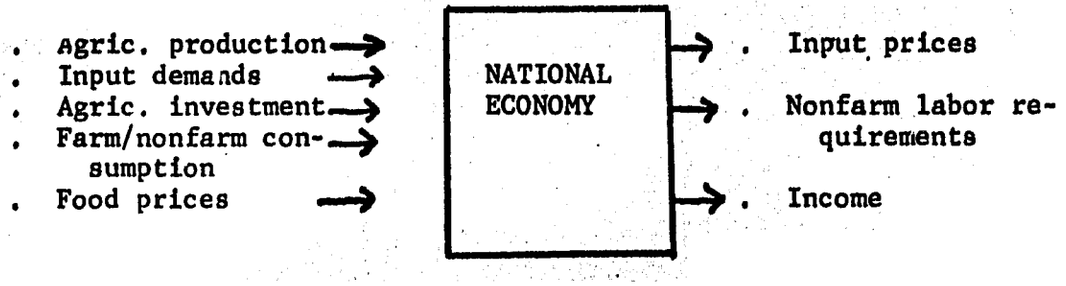
16-Sector Input-Output model to link agriculture and nonagriculture

- Sectors (16)
  - Agriculture (aggregation of agric. sector model) (1)
  - Other primary industries (2)
  - Manufacturing (8)
  - Social overhead capital (3)
  - Services (2)

Components

- Foreign trade and public demand
- Consumption (of non-food commodities)
- Investment
- Production (input-output)
- Labor
- Price

Sector Model Linkage



KASM3 : YIELDS AND INPUT DEMANDS COMPONENT

Production Function model to project yields and input application rates

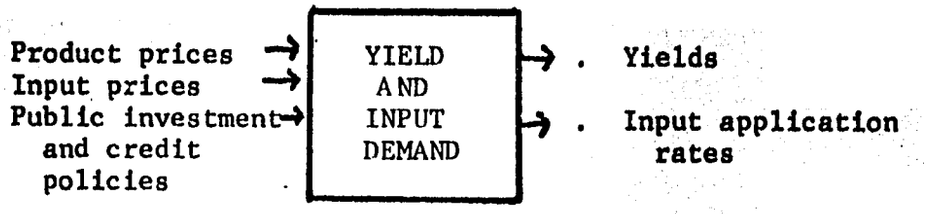
1) Input application rates optimized for each commodity with respect to

   - Yield responses
   - Product price
   - Input prices

2) Yields determined from production function by

   Input application rates
   Crop improvement (resulting from research and guidance investment)
   Land and water resources (resulting from public investment and credit policies)

Sector Model Linkage



KASM UTILIZATION FOR POLICY PLANNING

1975 • FIVE-YEAR PLAN ANALYSIS

- Project supply, demand, prices, imports, and exports of main agricultural commodities
- Project agricultural production input requirements
- Project agricultural trade balance
- Project farm household income and off-farm migration rat
- Project other more detailed economic, demographic, and nutrition indicators
- Update projections on an annual basis as new data becomes available

1975 • MEDIUM-RANGE ANALYSIS (5 - 15 years)

- Project above indicators out 5-15 years for medium-range planning
- Test impact of population control policies on food/population balance
- Analyze effect of changes in land area

1975 • PRICE POLICY ANALYSIS

- Test alternative producer and consumer price policies on supply, demand, imports, and exports of agricultural commodities
- Test effect of factor input price and subsidy policies on agricultural production and input requirements
- Determine impact of changes in world price trends particularly agricultural and energy on the domestic economy and the agricultural sector

USES OF KASM FOR POLICY PLANNING (con't)

1975 • PUBLIC INVESTMENT POLICY ANALYSIS

Analyze impact of public investment in

Biological research
Extension
Land and water development
Marketing infrastructure

on agricultural production and the demand for factor inputs (fertilizer, machinery, etc.) from the non-agricultural sector

Alternatively, analyze impact of supply constraints and/or prices of factor inputs on agricultural production resulting from investment policies in the nonagricultural sector

1976-77 • WEATHER IMPACT ANALYSIS

- Analyze the impact of unusually good or bad weather on

  . Agricultural production
  . Commodity prices
  . Farm incomes
  . National economy
  . Agricultural trade balance

1976-77 • REGIONAL ANALYSIS

- Analyze above factors on a regional basis by means of "flexible regionalization" (by province, river basin, or some other ecological region grouping) through interface with the agricultural data base at the gun level

- Determine optimal cropping patterns by region

USES OF KASM FOR POLICY PLANNING (con't)

1977-78 • MAF FISCAL POLICY ANALYSIS

- Project and analyze MAF fiscal policies
- Determine impact of large deficits in the special accounts on inflation
- Make projections of foreign loan repayment schedules

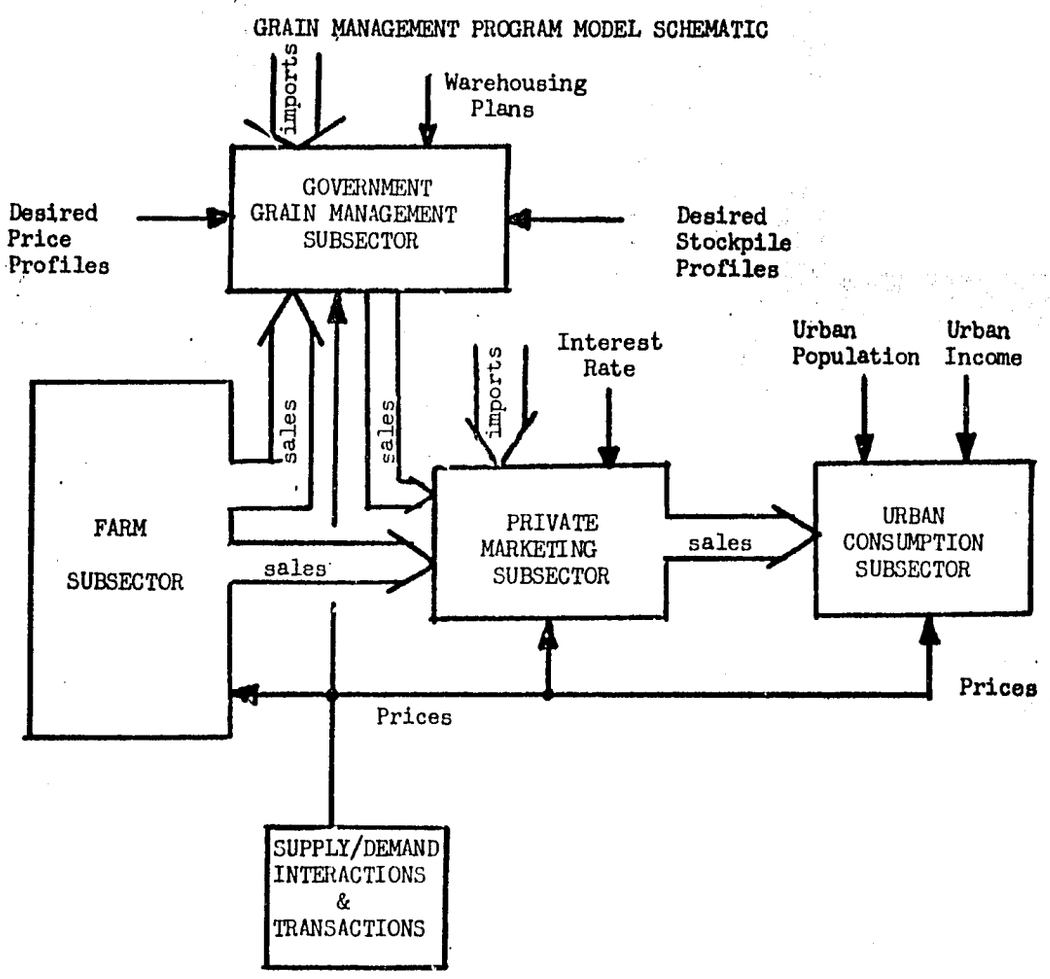
1979 • ANNUAL PRODUCTION PLANS

- Prepare annual production plans at the province level including distribution of factor inputs
- Formulate plans several years ahead for review and revision before implementation

GRAIN MANAGEMENT PROGRAM MODEL

GMP

GRAIN MANAGEMENT PROGRAM MODEL SCHEMATIC



Policy Influenceable Inputs

Import regulation (quantity and timing)
Government purchase of domestic grains (quantity and timing)
Government releases of domestic grains (quantity and timing)
Government buying and selling prices for domestic grains
Government investments in storage facilities
Factor input subsidies
Wheat flour subsidies

Performance Indicators

GMSA balances
Farm income
Farm consumption
Private market profits/losses
Private market growth/decay
Urban consumption
Urban nutritional levels
Foreign exchange expenditures
Private market prices
Programmed vs. actual results
- Seasonal price patterns
- Reserve stock levels
- Annual consumption plans

Etc.

GMP 1 CHARACTERISTICS

Major Food grain Commodities (3):	Rice Barley Wheat
Grain Forms (4):	Rough grains Hulled grains Polished grains Flour
Byproduct Forms (2):	Cracks Bran
Grain Processing Operations (3):	Hulling Polishing Flour milling
Grain Stock Position Points (7):	Farm households Production area points Consumption area terminal points Import Pipeline Seaports Retail sales points Urban household
Planning Horizon:	12 - 15 months
Time Increment:	1 - 2 day cycle

GMP: FARM SUBSECTOR COMPONENT

- Area/Yield Responses Determined by
  - Past trends
  - Net returns per hectare (profitability)
  - Fertilizer application rates
  - Seed varieties
  - Expected rainfall
- Grain Consumption/Substitution Determined by
  - Relative prices
  - Income
- Non-food Grain Demands Determined by
  - Seed requirements
  - Livestock feed requirements
- Farm-grain Stock Levels Determined by
  - Production
  - Marketing
  - Consumption
  - Current and projected price levels
- Farm Marketings Determined by
  - Farm grain inventories
  - Current and projected prices
  - Farm credit

GMP: GOVERNMENT SUBSECTOR

- Inventory-Flow Model of movement of grain commodities through government subsector:
  - Grain stocks by position
  - Grain stocks by physical form
  - Grain processing
  - Byproduct production
- Control Decisions
  - Market price
  - Reserve stock-level
  - Imports
- Investment Decisions
  - Government-controlled warehousing

GMP: PRIVATE MARKETING SUBSECTOR COMPONENT

- Inventory-Flow Model of movement of grain commodities through private marketing subsector:
  - Grain stocks by position
  - Grain stocks by physical form
  - Grain processing
  - Byproduct production
- Private decision-makers
  - Grain millers
  - Grain commissioners
  - Grain retailers
- Control Decisions
  - Profit-motivated storage activities

Investment Decisions

- Long-run storage capacity
- Long-run processing capacity

GMP: URBAN HOUSEHOLD SUBSECTOR COMPONENT

- Grain Consumption/Substitution Determined by
  - Relative prices
  - Income
- Urban Household Grain Stock Levels Determined by
  - Emergency stock level requirements
  - Available supply
  - Current and projected price levels
- Consumer Market Choices Determined by
  - Government/private market price levels
  - Government regulatory policies
- Urban Nutritional Levels/Deficits Determined by
  - Minimum requirements
  - Consumption levels

GMP: PRICE AND TRANSACTION MECHANISM

- Seasonal Farm Prices Determined by
  - Farm marketings
  - Private market demand
  - Government purchase programs (purchase prices, timing, etc.)
- Seasonal Consumer Prices Determined by
  - Private marketings
  - Government release programs (release prices, timing, etc.)
  - Consumer demands
- Producer selling transactions to private subsector vs. government subsector determined by
  - Private vs. government market producer prices
  - Market regulation
- Consumer buying transactions from private subsector vs. government subsector determined by
  - Private vs. government market consumer prices
  - Market regulation.

USES OF GMP FOR POLICY ANALYSIS

1975 . Historical Tracking for Model Verification

1975 . Historical Grains Policy Analysis
(What-if-we-had-done type questions)

- High price vs. low price policies
- Dual price policy programs
- Controlled market price programs
- Alternative import schedules

1975-76 . Short-term Grain Policy Formulation (12-15 months)
- Annual average grains prices
- Government purchase prices
- Government selling prices
- Government controlled industrial wheat flour prices/subsidies
- Government purchasing and release periods
- Import scheduling
- Seasonal market pricing objectives (flat, vs. scheduled seasonal price patterns)

1977-79 . Day-to-day guideline for amount and timing of government grain activities to attain grain policy objectives

- Programmed grain consumption levels
- Programmed annual grain prices
- Programmed seasonal price patterns
- Programmed grain reserve levels
- Programmed self-sufficiency goals